Geological Carbon Storage in 2030: European State of Play

Our prior work (Cavanagh and Lockwood, 2025) projected an operational EU capacity in 2030 of 8 to 39 Mtpa, with a P50 of 23 Mtpa.[1] We also noted that storage permits as the capacity metric were likely to approach the Net-Zero Industry Act (NZIA) target of 50 Mtpa.[2] The Commission's recent progress report has formally clarified that, under Article 23, compliance requires (a) an offtake agreement with an emitter, and (b) the award of a storage permit under the CCS Directive for at least five years of injection.[3] Operational status by 31 December 2030 is not required; permits are the measure.

Permit timing across ten European projects

Drawing on a four-decade timing record from the ten European projects to have so far received storage permits, the current trajectory typically delivers a permit within 4 years – Figure 1. On the available evidence, saline aquifers tend to take 3 years to permit, whereas depleted hydrocarbon fields average 4.5 years. The expected build time averages 3.5 years. On these timescales, we agree with the Commission's framing of the NZIA target as both realistic and ambitious.[2]

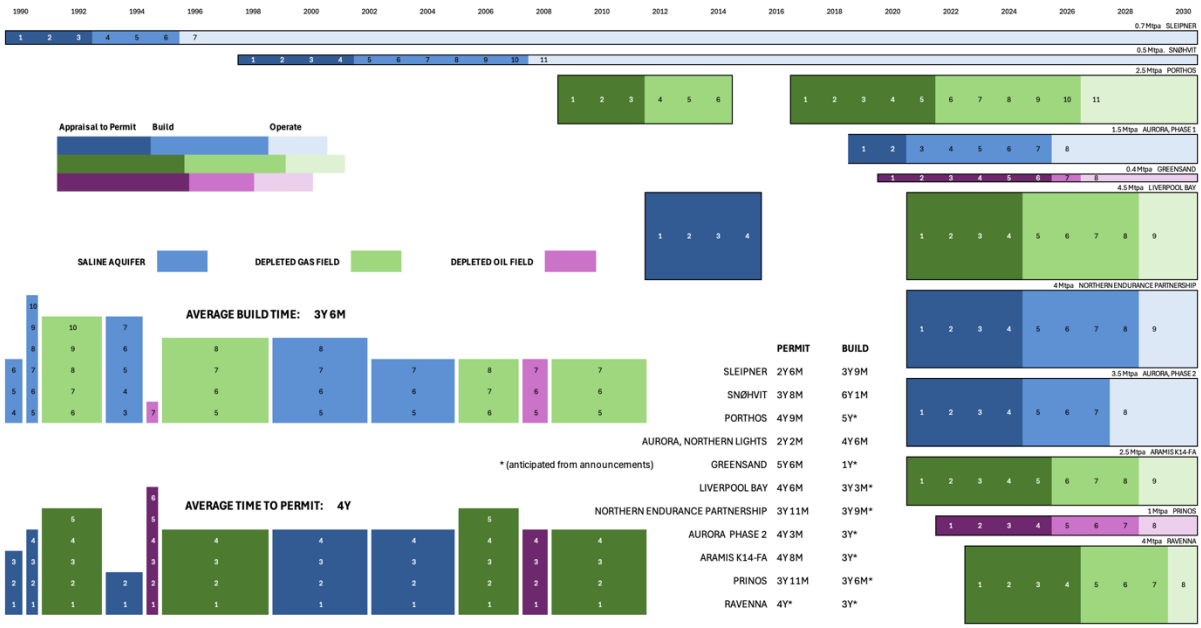

Figure 1 *Eleven European projects indicate about 4 years to permit, and 3.5 years to build.*

Given the significance of permits, we look at licensing terminology and ask the following question: Does the distinction between 'exploration,' 'appraisal,' and 'exploitation' licences in CO_2 storage regulations represent genuinely different regulatory permissions? Or do these terms describe loose and interchangeable phrasing across licensing regimes? For example, does the Norwegian 'exploitation licence' grant rights that supersede a storage permit under the EU CCS Directive, or are both required?

The Baseline – EU CCS Directive (2009/31/EC)

The CCS Directive establishes a two-stage framework for CO_2 storage within the EU and EEA.[4] The NZIA functions as the primary 2030 policy overlay, supplemented by revised Guidance Documents (DNV, 2024). The Directive makes no mention of 'appraisal' or 'exploitation' licences. Those are national constructs. The two stages are a minimum requirement; Member States may add stages.

- An exploration permit (Article 5), an exclusive time-limited right to explore an area for storage. It does not authorise injection. Member States may waive this step if sufficient data already exist.

- A storage permit (Article 9), the operational authorisation to inject. It is spatially defined and imposes obligations covering safety, monitoring, reporting, financing, and post-closure liability.

How National Frameworks Map to the Directive

Norway: Survey → Exploration Licence → Exploitation Licence + consent and permit for injection

Norway's CO_2 Storage Regulations (5th December 2014, No. 1517, under the Seabed Interventions Act 1963) create three distinct licence types: survey licence, exploration licence, and exploitation licence, plus a separate injection consent, *samtykke til injeksjon*, from the Ministry of Energy, and a storage permit, *lagringstillatelse*, from the Norwegian Environmental Agency. Exploration and exploitation are not phases of one licence; they are separate instruments with different rights and obligations – Table 1.[5]

UK: A single 'Carbon Dioxide Appraisal and Storage Licence' with sequential terms

The Energy Act 2008 and the Storage of Carbon Dioxide (Licensing etc.) Regulations 2010 (SI 2010/2221) diverge from CCS Directive terminology. The UK grants a single CS Licence comprising an 'appraisal term' (equivalent to the Directive's exploration permit) culminating in a 'carbon storage permit' (the Directive's storage permit) that oversees the 'operational term' and 'post-closure term'. These are not separate licences but contractual terms within one instrument.[6]

Denmark (EU): Exploration licence then storage permit, administered by DEA under the Subsoil Act

Denmark amended the Subsoil Act (*undergrundsloven*, s.23) in 2022. The Danish Energy Agency awards exploration licences (initially up to six years, extendable to ten) to investigate geological suitability. The licence holder has priority to apply for a storage permit (up to 30 years). The state holds a 20% stake in all licences through Nordsøfonden. As of 2025, three offshore and six onshore exploration licences have been awarded; the first storage permit was awarded to Greensand in 2025.[7]

Netherlands (EU): Two-stage transposition via the Mining Act (Mijnbouwwet)

The Netherlands transposed the CCS Directive directly into the Mining Act (*Mijnbouwwet*), introducing a CO_2 exploration permit (waivable for depleted gas fields with sufficient data) and a storage permit, both administered by the Minister of Economic Affairs and Climate Policy. Onshore storage is prohibited by statute following the cancelled Barendrecht project. Porthos, the EU's first commercial storage project, received two storage permits for P18-4 and P18-2 in 2022; FID was taken in October 2023, and the site is planning to be operational in 2027.[8]

USA, Canada, Australia: Well-permit or tenure-based regimes with no direct CCS Directive analogue

These jurisdictions have their own licensing regimes that resemble EU/EEA law. The USA operates a single Class VI UIC well permit. Australia uses a three-step sequence: greenhouse gas assessment permit → holding lease → injection licence, under the OPGGS Act 2006. Alberta uses an evaluation permit followed by a carbon sequestration lease.

Table 1 *The Norwegian 2014 Storage Regulations create four distinct sequential instruments*

Instrument	Chapter	Rights Conferred	Does It Authorise Injection?
Survey Licence	Ch. 2	Non-exclusive right to conduct seismic and desk studies; no exclusivity	No
Exploration Licence	Ch. 3	Exclusive right to explore a defined area; work programme obligation; drilling permitted	No
Exploitation Licence	Ch. 4	Exclusive right to develop a specific reservoir; right to construct facilities; right to submit an injection consent application	No. Injection requires an injection consent from the Ministry of Energy plus a storage permit from the Norwegian Environment Agency
Injection Consent	Ch. 5	Right to inject CO_2; the final development track authorisation from the Ministry of Energy	Yes. The operative authorisation to proceed; NB: The NEA storage permit is also required

Table 2 *A worked example, the Northern Lights (EL001 'Aurora') timeline from inception to operation*

Date / Period	Regulatory Milestone
Sep 2018	Application submitted for the exploitation licence (EL001), three months after the project starts in June 2018.
Jan 2019	Exploitation Licence EL001 'Aurora' awarded — first ever under the 2014 Regulations. Grants exclusive right to develop the Aurora reservoir; does not permit injection.[9]
Mar 2020	Eos well 31/5-A-7 spudded 2nd December 2019, completed 6th March, confirms reservoir characteristics.
May 2020	FID for Phase 1 taken 15th May 2020 (provisional on Ministerial approval); facility construction begins. The exploitation licence enables construction; a consent and permit are still required before any CO_2 is stored.
Mar 2021	Approval of PDO for Phase 1, 9th March 2021 by Norwegian Ministry of Petroleum and Energy. Equinor, Shell and TotalEnergies launch Northern Lights as a joint venture CO_2 transport and storage company.
Oct 2022	Phase 1 injection well (31/5-A-7 AH) spudded 9th October 2022 and completed in 24 days. The contingent well (31-5-C-1 H) was spudded 5th August 2022 and completed in 33 days. A stands for auxiliary, H for horizontal.
Dec 2022	Application to the NEA for a storage permit 9th December 2022. The NEA permit remains the operative equivalent to a CCS Directive 'storage permit'. Both a storage permit and injection consent are required.
Sep 2024	The receiving terminal at Øygarden, 100 km pipeline, and subsea injection facilities are completed.
Mar 2025	FID for Phase 2 taken 27th March 2025, increasing capacity from 1.5 Mtpa to at least 5 Mtpa.
Apr 2025	ESA issues an opinion on the storage permit from NEA, as required under Art. 10 of the CCS Directive. Phase 2 plan for development and operation (PDO) delivered to the Ministry of Energy on 1 April 2025.
Jun 2025	All required instruments in place: Ministry of Energy injection consent (Ch. 5 of 2014 Regs), NEA storage permit (Pollution Regulations Ch. 35), and Havtil consent (CO_2 Safety Regulations, CH. 12).[10] PDO approved 17 June.
Aug 2025	First CO_2 injected and stored on 25th August 2025.

Key findings across Jurisdictions

EU and EEA: The Directive's simple two-term model (exploration permit + storage permit) is mandatory. National transposition varies substantially in how these are labelled and structured, but the storage permit requirement is unambiguous.

Norway: Unique in creating four sequential instruments. Exploration and exploitation licences are distinct, separate instruments with different legal bases and rights. Only a combined injection consent and storage permit authorises operational storage. As of mid-2025, only one exploitation licence has been awarded (EL001, Northern Lights) – Table 2; the other ten NCS CO_2 licences are exploration licences. Sleipner and Snøhvit predate the CCS Directive and were licensed under domestic petroleum production and waste disposal regulations.

UK: The single CS Licence (with appraisal and operational terms) repackages the Directive's two instruments into one legal instrument. An exploration permit and storage permit remain conceptually present as distinct terms within the licence. Terminology differs from both the Directive and Norway.

Across these jurisdictions the labels 'exploration', 'appraisal', and 'exploitation' carry materially different rights. The term 'appraisal' is used in UK law as a phase within a single licence; in common industry usage it describes activities (well testing, site characterisation) that may occur under either exploration or exploitation licences elsewhere. 'Exploitation' in Norwegian law means the right to develop and construct, but not to operate injection. This is a common source of misreading; some literature conflates the Norwegian 'exploitation licence' with the Directive's 'storage permit.' These are not equivalent. the right to inject is performed by the combined Ministerial injection consent and NEA storage permit.

Conclusions

The Net-Zero Industry Act (Regulation (EU) 2024/1735) sets a binding EU target of 50 million tonnes of annual CO_2 injection capacity by 2030 and obligates 44 identified oil and gas producers to contribute pro rata to that target.[11] As of mid-2026, CATF analysis indicates that Shell, Eni, and TotalEnergies are

broadly on track; several Central and Eastern European producers face material shortfalls. Member States must set penalty frameworks by 30th June 2026. Obligated producers may contract third parties within the European Union to meet their contribution.[11]

As of July 2026, there are 19 EU projects that are licensed and on track to be permitted for storage by 2030. These sum to 42.4 Mtpa and span a wide maturity gradient. Denmark leads with six projects (16 Mtpa) and one storage permit for Greensand (4 Mtpa); Bifrost, Greenstore, Kalundborg, Ruby and Thorning are close behind. The Netherlands follows with another six projects (15 Mtpa) and two permits, for Porthos (2.5 Mtpa) and Aramis K14 (2.5 Mtpa), with Aramis L4 and L10 following and joined by the recently announced Abeona and Kompas projects. In southern Europe, Prinos has been permitted (2.8 Mtpa), with Ravenna (4 Mtpa) expected to follow shortly. TarraCO2, Devnya, Bockovac, Fieni-Botesti, and Danube are all preparing permit applications (4.6 Mtpa).

With the fastest storage sites being permitted in under three years, there is still time for new projects to close the gap of 7.6 Mtpa. These need to emerge in the next year or so. Average lead times of 4 years for permits mean that the 15 EU projects (30.6 Mtpa) in the appraisal phase as of mid-2026 are highly likely to join the four permitted projects (11.8 Mtpa) and contribute by the 2030 deadline.

References

1. Cavanagh & Lockwood (2025) Carbon Capture & Storage 2030: As the market takes shape, can Europe's CO_2 storage projects meet growing capture demand? IJGGC, 148, 104505.

2. EU (2024) Regulation 2024/1735 of the European Parliament and of the Council of 13 June 2024 (Net-Zero Industry Act, 'NZIA'), OJ L 2024/1735; Art. 23 (CO_2 injection capacity obligation).

3. EC (2026) Report to the European Parliament and the Council on the progress towards reaching the Union-wide target for CO2 injection capacity. Brussels, 28.5.2026 COM(2026) 252 final.

4. Directive 2009/31/EC of the European Parliament and of the Council of 23 April 2009 on the geological storage of carbon dioxide, OJ L 140, 5.6.2009, pp. 114–135 ('CCS Directive').

5. Norway (2014) Royal Decree of 5 December 2014 No. 1517, Regulations on Transportation and Storage of CO_2 in Subsea Reservoirs on the Continental Shelf. Chs. 2–5. s. 5-1.

6. NSTA (2024) NSTA awards Endurance first ever UK carbon storage permit. Press release, December 2024, accessed June 2026.

7. Denmark (2021) Subsoil Act (*undergrundsloven*), s. 23, as amended by Act No. 705 of 25 May 2021 and Act L 137 of 19 May 2022; DEA, 'Licences for Exploration and Storage of CO_2'.

8. EC (2023) Opinion on the draft permit to permanently store carbon dioxide in block section P18-2 (May 2022); European Commission, Fourth Implementation Report on Directive 2009/31/EC.

9. Norwegian Offshore Directorate (2019) 'Exploitation Licence EL001 Aurora Awarded', press release, January 2019 <https://www.sodir.no> accessed June 2026.

10. Northern Lights JV (2025) 'Northern Lights receives all required permits to start injecting and storing CO_2', press release, May 2025.

11. A23 Watch (2026) The first year of Article 23. Tracking Compliance, Progress and Perspectives on the CO_2 Injection Capacity Obligation in the EU. Annual Report. March 2026.